Galloper Wind Farm Project

Environmental Statement – Chapter 22: Geology, Hydrogeology, Land Quality and Flood Risk

October 2011

Document Reference – 5.2.22

RWE npower renewables

SSE Renewables

ROYAL HASKONING Enhancing Society

Document title	Galloper Wind Farm Project Environmental Statement – Chapter 22: Geology, Hydrogeology, Land Quality and Flood Risk
Document short title	Galloper Wind Farm ES
Document Reference	5.2.22
Regulation Reference	APFP Regulations, 5(2)(a)
Version	8
Status	Final Report
Date	October 2011
Project name	Galloper Wind Farm Project
Client	Galloper Wind Farm Limited
Royal Haskoning Reference	9V3083/R01/303424/Exet

Drafted by		Doug Watterson	
Checked by		Rufus Howard, Jon Allen	
Date/initials check		RAH / JA	18.08.2011, 07.09.2011
Approved by		Dr. Martin Budd (Royal Haskoning)	
Date/initials approval		MB	08.09.2011
GWFL Approved by		Kate Harvey	
Date/initials approval		KH	01.11.2011

CONTENTS

22 GEOLOGY, HYDROGEOLOGY, LAND QUALITY AND FLOOD RISK

22.1 Introduction

22.1.1 This Chapter of the Environmental Statement (ES) examines the geology, hydrogeology, land quality, hydrology and flood risk impacts associated with the construction, operation, and decommissioning phases of the onshore electrical infrastructure for the proposed Galloper Wind Farm (GWF) project.

22.1.2 It considers the potential impacts of the onshore development to the existing geological resource, upon hydrogeological (groundwater) sources (i.e. known aquifers), local watercourses (hydrology), land quality (the potential for contaminated land being present and / or the mobilisation of potential contaminants) and the generation of waste material. In addition the findings of a stand alone Flood Risk Assessment (FRA) are presented within this Chapter. The FRA is also included with this Development Consent Order (DCO) application.

22.1.3 For the purposes of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 this Chapter fulfils the requirements of Regulation 5(2)(l) in relation to the effects of the proposed development on the associated natural features (geological and hydrogeological features).

22.2 Guidance and Consultation

Policy and guidance

22.2.1 National Policy Statements (NPS) provide the primary basis on which the Infrastructure Planning Commission (IPC) is required to make its decisions. In preparing this Chapter the following NPS were reviewed:

- Overarching National Policy Statement (NPS) for Energy (EN-1) (DECC, 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b).
- NPS for Electricity Network Infrastructure (EN-5) (DECC, 2011c).

22.2.2 The specific assessment requirements for geology, hydrogeology, land quality and flood risk, as detailed within the NPSs, are repeated in the following paragraphs. The assessment requirements suggested within the NPSs have been applied to this assessment and where appropriate the specific sections of this Chapter that address the issues are indicated. Where any part of the NPS guidance has not been followed within this assessment, it is stated after the NPS text and a justification provided.

22.2.3 NPS EN-5 and EN-3 do not specifically consider geology, hydrogeology, land quality or flood risk impacts. However, EN-1 does include generic requirements. The following paragraphs of the guidance are relevant to this assessment.

Geology, hydrogeology and land quality

22.2.4 Paragraph 5.3.3 states that: "*Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance…..*" (See **Sections 22.6, 23.7** and **23.8** for geological sites. Designated sites of ecological importance are considered separately in **Chapters 8 Designated Sites** and **Chapter 23 Terrestrial Ecology**).

22.2.5 Paragraph 5.14.6 states that: "*The applicant should set out the arrangements that are proposed for managing any waste produced and prepare a Site Waste Management Plan. The arrangements described and Management Plan should include information on the proposed waste recovery and disposal system for all waste generated by the development, and an assessment of the impact of the waste arising from development on the capacity of waste management facilities to deal with other waste arising in the area for at least five years of operation. The applicant should seek to minimise the volume of waste produced and the volume of waste sent for disposal unless it can be demonstrated that this is the best overall environmental outcome*."

22.2.6 A Site Waste Management Plan will be developed once a principal contractor has been appointed, and is addressed in the Construction Code of Practice.

22.2.7 Paragraph 5.15.2 states that: "*Where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES or equivalent.*"

22.2.8 Paragraph 5.15.3 states that: "*The ES should in particular describe*:

- *The existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges.*
- *Existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Catchment Abstraction Management Strategies).*
- *Existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics.*

- *Any impacts of the proposed project on water bodies or protected areas under the Water Framework Directive and source protection zones (SPZs) around potable groundwater abstractions*."

22.2.9 With respect to the above NPS points, GWF has not specifically considered those aspects for the following reasons:

- GWF will not directly affect any water bodies and will not require any discharges to a water body;
- GWF will not require any water abstraction;
- GWF is located approximately 200m from the nearest surface water drain and will not result in any modification to an existing water body; and
- GWF is located over 1km from the nearest main river identified within the Anglian Region River Basin Management Plan (Leiston Beck and Minsmere Old River) and 200m from the nearest surface water land drain.

Potential impacts upon SPZs are discussed in **Section 22.6.**

Flood risk

22.2.10 Paragraph 5.7.4 states that: "*Applications for energy projects of 1 hectare or greater in Flood Zone 1 in England or Zone A in Wales and all proposals for energy projects located in Flood Zones 2 and 3 should be accompanied by a flood risk assessment (FRA).*" Paragraph 5.7.6 also states that: "*Further guidance can be found in the Practice Guide which accompanies Planning Policy Statement 25 (PPS25)".*

An FRA is included as part of the DCO application and also included as **Appendix 22.D** to this ES.

22.2.11 In addition, this assessment has been undertaken with due consideration of the following legislation and guidance (and amendments, where appropriate):

- Contaminated Land (England) Regulations 2006 SI 1380;
- Environmental Protection Act 1990;
- Environment Act 1995;
- Water Resources Act 1991 (Amendment) England and Wales) Regulations 2009;
- Groundwater Regulations 1998;
- The European Union (EU) Water Framework Directive 2000/60/EC;
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2003;

- Environmental Permitting Regulations 2010 (as amended);
- The Site Waste Management Plan Regulations 2008 S.I. No. 314;
- Environmental Protection (Duty of Care) Regulations 1991 SI 2839 (as amended);
- Wildlife and Countryside Act 1981 (as amended);
- Environmental Damage (Prevention and Remediation) Regulations 2009 SI 153; and
- Planning Policy Statement 25 (PPS 25) Development and Flood Risk.

Consultation

22.2.12 As part of ongoing consultation, key stakeholders were invited to respond to a scoping document produced as part of the EIA process (GWFL, 2010). **Table 22.1** summarises issues that were highlighted by the consultees in the IPC Scoping Opinion (IPC, 2010) and indicates which sections of the assessment address each issue.

22.2.13 Further consultation was undertaken through formal Section 42 consultation under the Planning Act 2008 (see **Chapter 7 Consultation**) via the submission of a Preliminary Environmental Report (PER). Community consultation under Section 47 has also been carried out in parallel with the Section 42 statutory consultation. The process for community consultation is set out in a Statement of Community Consultation (SoCC) (see **Chapter 7**). **Table 22.1** also summarises issues that were highlighted throughout the consultation period.

22.2.14 Full details of responses received are presented in the IPC Scoping Opinion report (IPC, 2010) and the Consultation Report that accompanies the DCO for this application.

Table 22.1 Summary of consultation and issues

Date	Consultee	Summary of issue	Section where addressed
August 2010	IPC (Scoping Opinion)	The Flood Risk Assessment should cover tidal flood risk as well as fluvial impacts. Reference should be included to surface water run-off and disposal, including details of proposed mitigation measures.	The Flood Risk Assessment addresses these issues and is included in full as Appendix 22.D
August 2010	Environment Agency	Where surface water infiltration methods are not feasible, then run-off rates	Drainage of the site will be achieved through infiltration. See Section

Date	Consultee	Summary of issue	Section where addressed
	(Scoping Opinion)	must be attenuated to the existing Greenfield rate.	22.7.
August 2010	Theberton and Eastbridge Parish Council (Scoping Opinion)	It should be noted that there has been overtopping from the sea in recent years below the Coastguard Cottages at Dunwich, and further north towards Walberswick. There has also been inland flooding in the fields adjacent to the Minsmere River, which flows out to sea at the Minsmere Sluice.	This has been captured within the baseline environment (Section 22.4).
July 2011	Environment Agency (Section 42)	We have no objection in principle to the development from a flood risk point of view, however, surface water disposal will have to be looked at within the FRA.	Surface water disposal is discussed within the drainage strategy which forms part of the Flood Risk Assessment (see Appendix 22.D)
July 2011	Environment Agency (Section 42)	Full copies of the referenced Greater Gabbard Offshore Wind Farm Phase I and II contaminated land reports should be provided.	These are provided as Appendices 22.A and 22.B
October 2011	Environment Agency	After reviewing the FRA and the associated drainage calculations, the EA have no objection to the proposed development from a flood risk point of view. Discussions with Suffolk Coastal District Council and Suffolk County Council should be undertaken regarding the long-term adoption and maintenance of the surface water features.	A commitment to discuss the maintenance and adoption of the surface water features is included in Section 22.7.

22.3 Methodology

Study area

22.3.1 The onshore development footprint (as shown in **Figure 1.3**) comprises the GWF substation (comprising the GWF compound and transmission compound) and sealing end compounds and associated laydown areas and access tracks.

22.3.2 It also includes the footprint of the cable corridor above Mean High Water Spring (MHWS) to the GWF substation including the onshore transition bays, temporary works areas, and the cabling between the GWF substation and the sealing end compounds.

22.3.3 Potential impacts associated with geology, hydrogeology, land quality and flood risk are not expected to occur beyond 1km of the proposed development (other than offsite flood/drainage flow impacts that are considered in the FRA). As such, the study area includes the onshore development footprint and any adjacent areas within 1km.

Characterisation of the existing environment

Geology, hydrology, hydrogeology and land quality

22.3.4 A Phase I land quality investigation was undertaken in 2007 (Royal Haskoning, 2007) to acquire information for the design of, and to support, the planning application and Environmental Impact Assessment for the onshore substation and cable route of the Greater Gabbard Offshore Wind Farm (GGOWF). A Phase II intrusive investigation was then undertaken following submission of the Environmental Statement for the GGOWF (Royal Haskoning, 2008).

22.3.5 The Phase I study area includes the proposed onshore development footprint of GWF. The Phase II study area is limited to the substation and cable corridor footprint for GGOWF. However, given that this is on land adjacent to the GWF substation it is considered that the Land Quality risks for GWF are suitably categorised by these previous investigations.

22.3.6 In order to assess the environmental baseline for GWF a review of the GGOWF Phase I and Phase II land quality investigations was undertaken to characterise the existing environment and to enable an assessment of the sensitivity of the various receptors.

22.3.7 These investigations included the following activities:

- The collation and examination of available local maps, historic plans, and photographs. Review and interpretation of environmental data from Regulatory Authorities or record holders, including potentially polluting processes, discharge consents, landfill sites, other potential

sources of pollution that are present on public registers, and licensed water abstraction points; and

- A review of the intrusive investigation of soils and groundwater completed for the GGOWF to test and assess the presence and risk associated with potential contaminants of concern.

GGOWF land quality phase I investigation

22.3.8 The Phase I investigation (Royal Haskoning, 2007) - refer to **Appendix 22.A** - covers an area that incorporates the intended site of the GWF substation and the proposed cable corridor. The study area of this desk study is shown in **Figure 22.1**. The information from the investigation provides useful data on the geology, hydrogeology, and land quality of the area of the GWF onshore envelope. A walkover (November 2010) of the proposed substation site confirmed that there had not been any land use changes to the site or the surrounding area, with the exception of the construction phase of the adjacent GGOWF substation, which has now been completed.

GGOWF land quality phase II investigation

22.3.9 The GWF site lies adjacent to, and partially within, the previously investigated Phase II area (see **Appendix 22.B**). The new cable corridor extends outside the area of the Phase II investigation and follows a similar route as the GGOWF cable corridor up to the point where the GGOWF crosses Sizewell Gap. The GWF onshore cable corridor continues west at this point and crosses Sizewell Gap approximately 250m further to the west and continues north to the GWF substation. The study area of the Phase II intrusive investigation is shown on **Figure 22.1**.

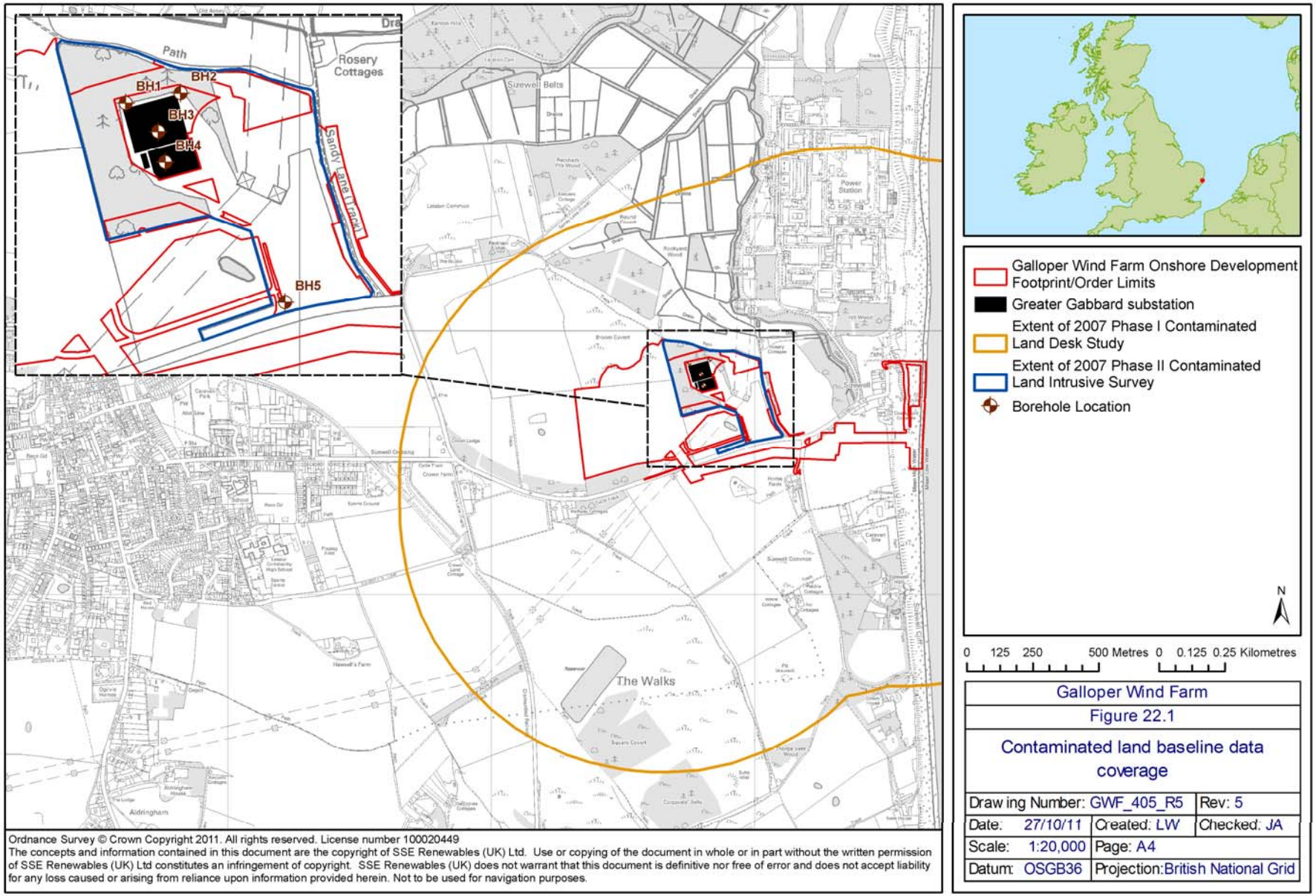
22.3.10 The investigation included five boreholes and 20 trial pits across the site. Four of the five boreholes had standpipes installed for groundwater sampling. A total of 41 soil samples and 12 groundwater samples from three monitoring rounds were analysed for the potential contaminants of concern identified in the GGOWF Desk Study. Contaminant concentrations were statistically assessed against Soil Screening Values (SSVs) derived for commercial end use of the site using the current version of the Environment Agency Contaminated Land Exposure Assessment (CLEA) model at the time of the Phase II investigation (Environment Agency, 2006). The Groundwater Assessment Criteria (GWACs) used were mainly based on the UK Environmental Quality Standards (EQS).

22.3.11 Since the release of the CLEA UK model a number of updates to the CLEA model human health risk assessment tool have been issued, the most recent being CLEA 1.06. An updated human health risk assessment has been undertaken using the CLEA 1.06 model and is provided as **Appendix 22.C**.

Other sources of data

22.3.12 Other data sources were also consulted as part of the GWF assessment, these included:

- Ordnance Survey (OS) and British Geological Survey (BGS) mapping;
- Data supplied by the Environment Agency (EA); and
- Institute of Geological Sciences hydrogeological mapping.



Flood risk

22.3.13 Information has been taken from various sources, such as the Environment Agency's flood zone map and the Strategic Flood Risk Assessment for the Suffolk region to inform the Flood Risk Assessment (FRA) (Royal Haskoning, 2011). Interferometric Synthetic Aperture Radar (IFSAR) data has been obtained to study the terrain of the sites and its surroundings. Using this terrain data it is then possible to assess the likelihood of flooding at the development site. The FRA is provided in full as **Appendix 22.D**.

Assessment of impacts

22.3.14 Taking account of the likely magnitude of identified impacts from the works, potentially significant effects are predicted and appropriate mitigation measures are proposed. Good practice techniques for the construction, operation, and decommissioning phases are also recommended in order to avoid significant impacts or to mitigate them further.

22.3.15 The assessment of impact significance for land quality and water resources has been undertaken for the entire onshore development footprint and considers the impact to potential receptors within a 1km radius.

Geology, hydrogeology, hydrology and land quality

22.3.16 Potential impacts arising from the construction, operation, and decommissioning of the onshore works are identified and assessed taking into account the following elements of the development area's environmental baseline and their sensitivities:

- Site geology;
- Location and condition of watercourses and static water bodies in proximity to the site;
- The potential presence of groundwater aquifers and potential pathways beneath the site and surrounding area;
- The potential presence of Groundwater Source Protection Zones in proximity to the site; and
- Any past or present sources of land contamination.

Flood risk

22.3.17 The potential for flood risk impacts is based on the findings of the FRA (provided in full as **Appendix 22.D**), which strictly adheres to the requirements of PPS 25 *Development and Flood Risk* rather than the standard EIA methodology given in **Chapter 4 EIA Methodology**.

Receptor sensitivity

22.3.18 The sensitivity of receptors has been considered based on the generic criteria provided within **Table 22.2**

Table 22.2 Generic criteria for receptor sensitivity

	Definition			
Sensitivity	**Hydrology**	**Hydrogeology**	**Land quality**	**Geology**
High	Main rivers, lakes or ponds, licensed water abstractions, or designated for ecological value	Groundwater Source Protection Zones Principal Aquifers	Contaminants very likely to represent an unacceptable risk to potential receptors	Deposit rare Deposit/strata value high (national importance/designation
Medium	Drains that discharge to a highly sensitive site	Secondary A Aquifers	Contaminants likely to represent an unacceptable risk to potential receptors	Deposit localised Deposit/strata value medium (regional importance/designations)
Low	Drains that do not discharge to a highly sensitive site	Secondary B Aquifers Secondary Undifferentiated Aquifers	Contaminants may be present but unlikely to create unacceptable risk to potential receptors	Deposit moderately widespread Deposit/strata value low (local importance/designation) or no value
Negligible	Non water bearing receptors	Unproductive Strata	If contamination sources are present they are considered to be minor in nature and extent	Deposit widespread No deposit/strata value (no designation)

Impact magnitude

22.3.19 The impact assessment is based on the following factors and professional judgement. Justification for impact magnitude is included in **Sections 22.6** to **22.10**.

22.3.20 The assessment includes the development of a conceptual site model (source, pathway and receptor contaminant linkage model) against known assessment criteria. A summary of the assessment criteria applied for each receptor is shown in **Table 22.3**.

Table 22.3 Summary of generic assessment criteria relating to the magnitude of effect

	Receptor		
	Hydrology	**Hydrogeology**	**Land quality**
Generic Assessment Criteria	Environmental Quality Standards UK Drinking Water Standards	Environmental Quality Standards UK Drinking Water Standards	CLEA v1.06 GAC (Various Land Use Scenarios) Environmental Quality Standards UK Drinking Water Standards

22.3.21 Where an assessment criteria is exceeded for any receptor, further detailed risk based assessment is required.

22.3.22 Where an impact cannot be quantitatively assessed it is considered that the magnitude of the effect is based on the quantity, level of hazard and the likelihood of the pollution event.

Impact significance

22.3.23 Following the assessment of the sensitivity of a receptor and the impact magnitude it is possible to assess the significance of the impact. **Table 22.4** provides generic definitions for each impact significance category.

Table 22.4 Generic definitions for impact significance

Impact significance	Generic definition
Major adverse	Major threshold exceedance at a highly sensitive receptor
Moderate adverse	Minor threshold exceedance at a highly sensitive receptor; or major threshold exceedance at a low sensitivity receptor.
Minor adverse	Minor threshold exceedance at a low sensitivity receptor.
Negligible	The impact is sufficiently small as to be indeterminable and of no concern.
None	No identifiable impact.

22.4 Existing Environment

Land use

22.4.1 The cable landfall is located on Sizewell Beach to the south of the existing Sizewell nuclear power stations. This stretch of dune and shingle beach is regularly used by walkers and also includes a small number of fishing boats.

22.4.2 The village of Sizewell is located inland of the beach, to the south of the Sizewell nuclear power stations and comprises a small number of residential properties, a public house, café, and a public car park.

22.4.3 Inland of Sizewell Village the land is typically arable and pastoral in nature. The proposed onshore cable corridor is predominantly within arable land. The GWF substation footprint is again largely located within arable farmland, and partially within woodland and pasture grassland.

Topography

22.4.4 The location of the proposed landfall is shingle beach shoreline, which is oriented north-south, with the shingle ridge typically 2m above Ordnance Datum (AOD). Two static sand dune ridges are situated landward of the shingle with the land rising to approximately 4m AOD at the first of the dunes and approximately 6m AOD at the second. The cable corridor ties into the onshore transition bays, which sit in arable land beyond the sand dune ridges and a low cliff bluff at approximately 11m AOD. From the transition bays, the cable corridor continues in a westerly direction parallel to Sizewell Gap dropping down to the 5m contour before crossing the access road which leads to Home Farm, at 3.5m AOD. The cable corridor then turns north and crosses Sizewell Gap and steadily rises in elevation to approximately 11m AOD. The proposed substation sits on land that is between approximately 9m AOD and 12m AOD.

Geology

Published Geology[1]

22.4.5 The geology underlying the area is illustrated on the British Geological Survey (BGS) solid and drift geology map of the area (Sheet 191; Saxmumdham) and is characterised by the Pleistocene Crag Group, which comprises undivided (Norwich) Crag, Chillesford Clay and, potentially, Red Crag in parts.

22.4.6 The Crag is described as yellow or red / brown beds of sand, laminated clays and pebbly gravels. The Red Crag is indicated to be composed of beds of sands, which are shelly in places, with occasional silty bands and layers of ironstone. The thickness of this group is shown to be up to 55m.

22.4.7 The Red Crag Group is unconformably underlain by the Harwich Formation, comprising sandy siltstones and sandy mudstones, with volcanic ash layers and the Hales Clay Member at the base (sandy mudstones), up to 17m in thickness.

22.4.8 The Harwich Formation, in turn, unconformably overlies the Lambeth Group (mottled mudstones giving way to sands and silts with depth). Beneath the Lambeth Group unconformably lies the mudstones of the Ormesby Clay Formation and the unconformable boundary to the Upper Chalk.

22.4.9 Close to the coast, drift deposits are generally absent and not indicated to overly the Crag Formation at the substation site or cable corridor. However, in the far west of the site a pocket of overlying Quaternary Sand and Gravel and undivided mainly chalky, pebbly sandy clay of the Lowestoft Till Formation is indicated to occur within the development site boundary. The map shows that clay may also be present in the south-west of the development site boundary. A schematic representing the solid geological formations from the surface down to bedrock is presented in **Box 1**.

Encountered ground conditions

22.4.10 The Phase II investigation of the GGOWF substation site found that the soils on site were predominantly orange to yellow, fine to medium sand, with areas of grey to brown sandy clay. Flint and chalk gravels were present in both the sand and clay layers at varying depths, across the majority of the site. Topsoil was encountered over the majority of the site, and half of the 24 exploratory locations encountered clay. The clay was only encountered in the western half of the site, both in the Sizewell Wents woodland and in the arable field. It was found at varying depths between 0.1m and 6.3m below ground level (mbgl).

[1] Reference has not been made to unpublished geology for the site (e.g. BGS borehole logs) since geotechnical boreholes have already been commissioned within the site itself.

Box 1: Schematic of geological layers and hydrogeology

Geological Unit	Hydrogeological Properties	Approximate depth metres below ordnance datum (OD)
Ground surface		
Pleistocene Crag Group (yellow or red / brown beds of sand, laminated clays and pebbly gravels)	Secondary aquifer	0-50
Harwich Formation (siltstones and sandy mudstones, with volcanic ash layers)	Non-aquifer	50-100
Hales Clay Member (sandy mudstones)	Non-aquifer	
Lambeth Group (mottled mudstones giving way to sands and silts)	Non-aquifer	
Ormesby Clay Formation (mudstones)	Non-aquifer	
Upper Chalk	Principal aquifer	100-350

22.4.11 Within the study area there are no Regionally Important Geological Sites (RIGS), no sites listed within the Geological Conservation Review nor any Sites of Special Scientific Interest designated for geological interest. As such, the study area is considered to be of low sensitivity for geology.

Hydrogeology

Published hydrogeology

22.4.12 The study area is described on *Hydrogeological Map No.5*: *Southern East Anglia* and on *Groundwater Vulnerability Map No. 33, East Suffolk*. The hydrostratigraphic units underlying the site comprise Crag Deposits (secondary aquifer), London Clay, Lower London Tertiaries (non-aquifer), and Chalk (principal aquifer). The London Clay and majority of the Lower London Tertiary units are non-aquifers which effectively act as an aquitard (impermeable layer along an aquifer). See **Box 1** for a schematic of the hydrogeological formations.

22.4.13 The classification as a 'Principal Aquifer[2]' refers to the chalk aquifer; the overlying Crag deposits are indicated to be a 'Secondary Aquifer[3]' which is defined as a body which also has significant water resources but with hydraulic properties which limit over-exploitation. These aquifers would not normally warrant special consideration for Catchment Abstraction Management Strategy (CAMS) but may still support locally important abstractions and dependent ecosystems which may be subject to risks associated with pollution pressures. The site, however, does not sit within a Source Protection Zone (SPZ), the nearest being over 1km further to the west at Leiston which is 'up gradient' of the development site boundary, therefore there can be no hydrological movement from the development to this SPZ.

22.4.14 Although the site is underlain with both Principal and Secondary aquifers, the Principal aquifer is 100m below ground level with London Clay above it (acting as an aquitard). As such, the Secondary Aquifer is of more relevance to the proposed GWF and the site is therefore assessed as medium sensitivity for hydrogeology.

Encountered groundwater conditions

22.4.15 Groundwater monitoring wells were installed, as part of the GGOWF Phase II investigation, to provide information on groundwater levels and quality within the shallow aquifer beneath the site. During the monitoring campaign, groundwater was encountered in all 5 boreholes across site. **Table 22.5** illustrates the groundwater strike and rest levels. The location of these boreholes is shown on **Figure 22.1**.

22.4.16 In order to calculate the direction of groundwater flow, the standing water level in relation to ordnance datum has been calculated, and is presented in **Table 22.6**. A further borehole (BH10) was installed during a separate

[2] Principal aquifers are layers of rock or drift deposits that provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

[3] Secondary aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. They may support water supplies at a local rather than strategic scale, and in some cases form an important source of base flow to rivers.

geotechnical investigation for the GGOWF substation and has been used to calculate the groundwater flow direction.

22.4.17 Assessment of these levels show that the overall groundwater flow is approximately in a north-easterly direction, towards a series of drainage channels flowing north-eastwards into Sizewell Belts.

22.4.18 There is one licensed groundwater abstractions held within 500m of the site. The licence is for crop irrigation and is not considered to be a sensitive receptor. There are no water abstractions proposed as part of the GWF development.

Table 22.5 Groundwater Strike and Rest Levels

Borehole ID	Groundwater Strike (mbgl)	Groundwater Rest (mbgl)	Standing Water Level (mbgl)		
			15/01/2008	22/01/2008	29/01/2008
BH1	6.00	5.90 (after 10 mins)	6.35	6.11	6.07
BH2	4.00	3.80 (after 10 mins)	4.10	3.92	3.91
BH3	9.20	7.65 (after 20 mins)	No well installed		
BH4	9.00	8.15 (after 20 mins)	8.65	8.54	8.50
BH5	3.45	3.05 (after 10 mins)	3.44	3.39	3.39

Table 22.6 Standing Water Levels

Borehole ID	Ground Level (m AOD)	Standing Water Level (m AOD)		
		15/01/2008	22/01/2008	29/01/2008
BH1	6.99	0.97	1.21	1.25
BH2	4.75	0.96	1.14	1.15
BH4	9.48	1.13	1.24	1.28
BH5	4.43	1.31	1.36	1.36
BH10	3.64	-	1.19	1.19

22.4.19 Considering the classification of the underlying area as a secondary aquifer, and that groundwater has been identified beneath the site, the hydrogeology is considered to be of medium sensitivity.

Hydrology

22.4.20 The onshore development footprint does not include any surface water bodies and drains via surface infiltration. A number of drainage channels run through the area known as Sizewell Belts to the north of the site, the nearest of which passes approximately 100m north of the development site boundary. The drains of the Sizewell Belts area discharge into Leiston Brook (approximately 1.7km north of the development boundary). Leiston Brook is a tributary of the Minsmere River which outfalls at Minsmere sluice approximately 3.35km north of the development site boundary.

22.4.21 According to the Environment Agency (www.environment-agency.gov.uk) Leiston Brook is classified as a heavily modified water body and is expected to achieve Moderate Ecological Potential in 2015, i.e. it is not expected to achieve Good Ecological Potential.

22.4.22 The nearest water bodies to the site include a ponded hollow located approximately 50m to the south of Sizewell Wents. This surface water feature appears to be a temporarily flooded area of an arable field, rather than an established pond, and did not contain any water during a walkover survey during November 2010. A second water feature is located approximately 120m south of Sizewell Gap, within Home Farm, situated in a former quarried / scrub area. This is approximately 350m south of the proposed substation location, and 75m south of the cable corridor.

22.4.23 There are no sensitive surface water features within the development site boundary, and no active licensed surface water abstractions within 1km of the site. The network of drains 100m to the north of the development site boundary feeds Sizewell Belts - an area that is also designated as a Site of Special Scientific Interest (SSSI); however, there is no direct surface water connectivity (although subsurface flows are possible) between the onshore

development and these drains. As such, the hydrology in the study area is considered to be of medium sensitivity.

Land quality

Phase I Land Quality Desk Study (Appendix 22.A)

22.4.24 Through the review of historic and current environmental information, and the development of the conceptual site model (source, pathway, and receptor contaminant linkage model), the potential sources of contamination that have been identified in relation to the site are presented in **Table 22.7**.

Table 22.7 Summary of Potential Sources of Contamination

Environmental Data	Within development Site Boundary	0m -250m	Comment
Discharge consents	0	0	No discharge consents within 250m of the site. The nearest licensed discharges are associated with Sizewell Power Station.
Pollution Incidents to controlled waters	0	0	Three incidents have been recorded prior to 1997 and were classified as minor discharges to Leiston Brook. Considering the age, distance and severity, they are not considered significant.
Licensed Waste Management Facilities and Landfills	0	0	There has been one landfill in the area, 300m south of the site at Home Farm. The licence has been revoked. Considering the distance of the facility, the likelihood of the landfill affecting the development is considered to be medium.

Environmental Data	Within development Site Boundary	0m -250m	Comment
Integrated Pollution Controls (IPC) and Integrated Pollution Prevention and Control (IPPC) authorisations.	0	0	There are many IPC authorisations relating to Sizewell Power Station cited over 500m away. These are not considered likely to affect the site, given their distance from the site.
Enforcements, prohibitions or prosecutions.	0	0	None recorded.
Fuel storage sites	0	0	None recorded.
Contemporary Trade Directory records (active and former)	0	4	Four trade directory entries are listed in the Desk Study, all of which are listed as 'active'. These relate to rubber and plastic products manufacturing at Home Farm, approximately 170m south of the development site boundary, and power transmission services at Sizewell A and B Power Stations.
Flood Risk			None of the development site boundary falls within Flood Zones 2 and 3 as indicated on the Environment Agency Indicative Floodplains Map. A flood risk assessment has been carried out for this site.
Risks from coal mining			No coal bearing strata have been identified in the study area.

Phase II Land Quality Investigation (Appendix 22.B)

22.4.25 The Phase II investigation undertaken in 2008 for the GGOWF development included five boreholes and 20 trial pits across the site. A total of 41 soil samples and 12 groundwater samples in three monitoring rounds were collected.

22.4.26 As part of this Phase II Investigation risk assessment, a conceptual site model outlining pollutant linkages was developed and the pollutant linkages identified were assessed by comparison of the contaminant concentrations found on site to the SSVs and GWACs.

22.4.27 The key conclusions of the risk assessment are:

- No significant risks to site users have been identified, as none of the contaminants tested were found to exceed the SSV from the 41 soil samples analysed. Additionally, twenty samples were tested for asbestos, with no fibres being detected in any of the samples[4]; and
- No significant risks to controlled waters have been identified as none of the contaminants tested were found to exceed the GWAC from the 12 groundwater samples analysed over the three rounds of monitoring.

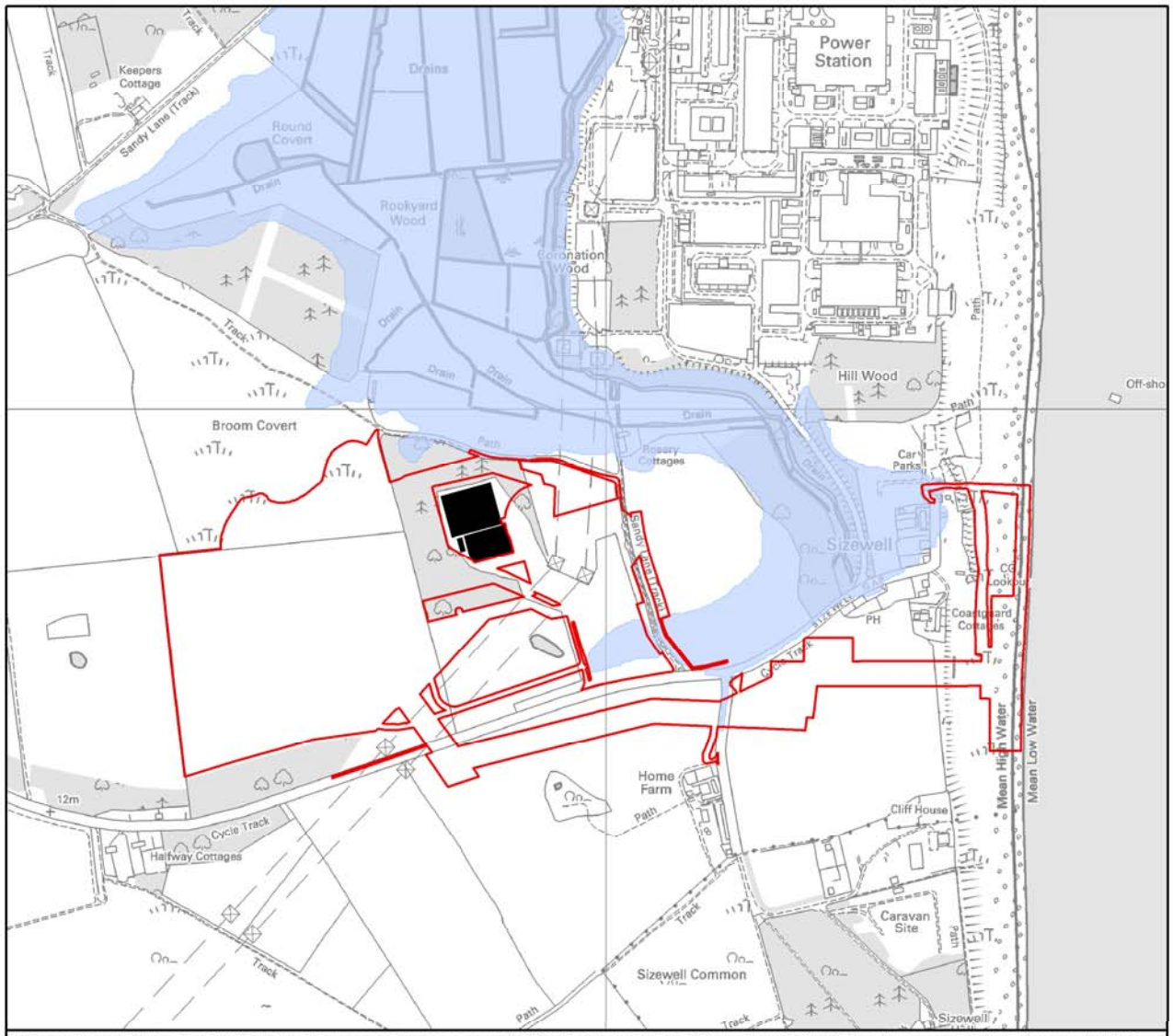
22.4.28 No significant pollutant linkages have been identified, and as such the sensitivity of the site to potential land quality impacts is considered to be low.

Flood risk

22.4.29 The proposed GWF onshore development is not at risk from river or sea flooding according to the Environment Agency's Flood Zone map; refer to **Figure 22.2**, which shows Flood Zones 2 and 3. There has been occasional overtopping of the sea defences near Dunwich (approximately 8km north of the onshore development footprint) as well as inland flooding at Minsmere (Theberton and Eastbridge Parish Council, *pers. Comm..* 2010); however, both of these areas are shown to be at flood risk on the described Flood Zone mapping.

22.4.30 The proposed GWF onshore development sits within Flood Zone 1 defined in PPS25 as Low Probability - and assessed as having a less than a 0.1% annual probability of river or sea flooding in any year. As such, the risk of flooding in the area is considered to be low. The FRA is provided in full as **Appendix 22.D**.

[4] Risks from asbestos are not assessed using the CLEA model but on a presence or absence basis.



Galloper Wind Farm Onshore Development Footprint/Order Limits

Greater Gabbard substation

Zone 2 Extreme Flood from Rivers or Sea without Defences

N

0 50 100 200 Metres 0 0.05 0.1 0.2 Kilometres

Galloper Wind Farm		
Figure 22.2		
Areas at risk of flooding		
Drawing Number: GWF_406_R5		Rev: 5
Date: 27/10/11	Created: LW	Checked: JA
Scale: 1:10,000	Page: A4	
Datum: OSGB36	Projection: British National Grid	

Summary of the sensitivity of geological, hydrogeological, hydrological, land quality and flood risk receptors

22.4.31 A summary of the sensitivity of the receptors is provided in **Table 22.8**.

Table 22.8 Summary of Receptor Sensitivity

Receptor	Description	Sensitivity
Geology	There are no citations within the Geological Conservation review or SSSI's designated for geological interest.	Negligible
Hydrogeology	The site is situated in an area underlain by a secondary aquifer. Shallow groundwater is considered to potentially facilitate the migration of contaminants.	Medium
	The principal chalk aquifer is overlain by London clay and is not considered a sensitive receptor.	Low
	A groundwater abstraction for crop irrigation.	Negligible
Hydrology	Drains, approximately 100m north of the onshore development boundary, are a non classified water body. These drains form part of Sizewell Belts (an area designated as a SSSI).	Medium
Land Quality	No significant pollutant linkages have been identified.	Low
Flood Risk	Site sits within Flood Zone 1 defined in PPS25 as Low Probability - and assessed as having a less than a 0.1% annual probability of river or sea flooding in any year.	Low

22.5 Assessment of Impacts - Worst Case Definition

22.5.1 Within the onshore development footprint appreciable flexibility is only permitted within the GWF compound, transmission compound and onshore cable corridor. Flexibility within the two compounds applies to equipment / building location and the finished floor level. The finished floor level is between 8m and 9m above Ordnance Datum (AOD). For the purpose of this

assessment the lowest level (8m AOD) has been assumed throughout as this would give rise to the greatest potential flood risk impact in these respects.

22.5.2 Flexibility within the cable corridor permits the permanent works to lie within a defined overall extent of the temporary works. Since this assessment considers the impact of the entire temporary works, and there is no distinction between that temporary or permanent nature, the flexibility is not relevant to this assessment.

22.5.3 This assessment also assumes that the substation development will require 20-30m deep piling and also the incorporation of an earthing mat which could also include short rods to be drilled into the ground.

22.5.4 Full details on the range of flexibility being considered by Galloper Wind Farm Ltd are provided in **Chapter 5 Project Details**. The assessment in this Chapter is based on the maximum extent of compound and cable works shown in **Figure 1.3**.

22.6 Assessment of Impacts during Construction

Impacts to local geology

22.6.1 As outlined in **Chapter 5 Project Details**, excavation activities will include directional drilling, surface excavation and earth moving during cable laying and site preparation for the substation and other onshore infrastructure. There is also the potential for deep piling of foundations which could be up to 20-30m in depth. These excavations have the potential to disturb the local geology. However, as no sensitive geological features have been identified along the route of the cable corridor, substation and associated infrastructure, there is expected to be **no impact** upon the local geology. No mitigation measures are considered necessary.

Contamination of secondary aquifer (hydrogeology)

22.6.2 There is the potential for contamination from accidental leaks and spills from construction vehicles and fuel storage onto the ground surface that could penetrate into the underlying strata. Secondary aquifers are of medium sensitivity and a **potential minor adverse impact** is predicted in the absence of mitigation.

Contamination of principal aquifer (hydrogeology)

22.6.3 The cable corridor and substation location are underlain by principal aquifer systems (Upper Chalk). These principal systems are, however, overlain by London Clay, which due to its composition presents an impermeable barrier to vertical migration of potential contaminants.

22.6.4 As outlined in **Chapter 5 Project Details**, excavation and drilling activities will include both relatively large-scale areas for the substation, and relatively small-scale sections of shallow depth for the export cables and onshore transition bays and sealing end compounds. Depths of excavation during

construction will vary from approximately 1-2m along the cable corridor and 2m – 3m for the onshore transition bays. In addition, it is assumed that piling will be required for some of the substation buildings, and the installation of the electricity earth mat beneath the substation may also require narrow rods to be drilled 15m into the ground to act as an 'earth' for the substation.

22.6.5 These depths will not extend beyond the thickness of the London Clay (which is approximately 100m deep) and expose the chalk aquifer beneath to any potential contaminants at the surface (as indicated in **Box 1**). As such, **no impact** is predicted upon the major aquifer system during construction.

Pollution of hydrological receptors (hydrology)

22.6.6 Excavations are likely to increase localised soil erosion and mobilised sediment can, under certain circumstances, make its way into nearby watercourses through surface runoff. Depending on the scale of the excavation works, mobilised sediment can have serious adverse effects on the geomorphological and ecological functioning of a receiving watercourse and, as such, watercourses are afforded protection from silt run-off under Section.85 of the Water Resources Act 1991.

22.6.7 The surface water features across the study area are generally small and few in number, and the nearest sensitive watercourse is 100m from the development site boundary (a drain within Sizewell Marshes SSSI). Sizewell Marshes SSSI is located approximately 100m from the proposed substation works and 10m from the proposed cable corridor at its nearest point. Sizewell Marshes represents a hydrological receptor of medium sensitivity.

22.6.8 The increased risk of contaminated run-off entering Sizewell Marshes SSSI is limited, due to lack of hydrological connectivity with the development site, and the current land use of the site being made up of exposed soils. However, in the absence of mitigation there remains the potential for an impact of **minor adverse** significance.

Risk to site worker health (land quality)

22.6.9 Digging or drilling through potentially contaminated soil or waste materials (e.g. made ground) could impact upon site worker health via dermal (direct) contact, ingestion or inhalation of soil, dust and/or any ground gases. Site workers would be in close or direct contact with contaminants, if present. However, the human health risk assessment (part of the Land Quality Assessment) indicates a low risk from contamination if appropriate Personal Protective Equipment is used as a result of a risk assessment, and as such the impact prior to any mitigation measures is assessed to be **negligible**.

Mobilisation of contaminants by rainfall (land quality / hydrogeology)

22.6.10 The construction phase of the onshore development will involve the digging of open trenches (within soil and bare shingle), topsoil strip for various temporary works, HDD, earthmoving and laying foundations for the

substation, and excavation of onshore transition bays. These activities may enable greater percolation of rainfall across the working area and the mobilisation of contaminants, if present. However, no significant potential sources of contamination have been identified in the vicinity of the cable corridor or substation site and as such the impact prior to any mitigation is assessed to be **negligible**.

Generation of waste materials

22.6.11 The installation of cables and associated structures (e.g. onshore transition bays) and reducing ground levels for the onshore substation will require the excavation of soil. Material that is excavated and reinstated directly will not be classified as a waste. Material, if not directly reinstated from where it was excavated may be reused elsewhere within the onshore works if it has the appropriate chemical and physical properties. Given the low probability of any inappropriate material being won as part of the earthworks, it is expected that all such material will be reused on site.

22.6.12 Throughout the HDD process, the volume of drilling mud which returns to the sumps will depend on the ground characteristics. In some situations, the majority is absorbed into the ground and little drilling mud returns to the sump pit. In other conditions, large quantities of drilling mud will return to the sumps. The sumps will be regularly emptied and any solids and drilling mud arising from the drilling operations will be temporarily stored on-site in containers within bunds.

22.6.13 The contractor will be responsible for testing the waste mud to classify it as hazardous or non-hazardous waste as appropriate. Any wastes found to be hazardous, will be stockpiled separately from any non-hazardous stockpiles. Waste will only be taken off site by contractors who hold a valid waste carrier's registration.

22.6.14 The drilling mud will be assessed by the contractor to determine the most appropriate waste management option in accordance with the waste hierarchy. If landfill is chosen, the contractor will be responsible for disposing of it in the appropriate class of landfill, at a site holding a valid environmental permit, after ensuring that the pre-treatment requirements have been met and carrying out the appropriate waste acceptance criteria testing where relevant.

22.6.15 Chemically and physically unsuitable material from any excavations will be characterised, segregated, and disposed of. Excavated materials will also be temporarily stored within the development boundary before use on site or appropriately disposed (in the unlikely event that small quantities are unsuitable for reuse in the landform),

22.6.16 The creation of any waste materials that cannot be re-used within the scheme will require disposal and will expend room within a landfill facility. However, the expectation for the onshore works is to reuse all material won

from the excavations in the construction of the screening landform detailed in **Chapter 20 Seascape, Landscape and Visual Character**. It is expected that most materials generated from excavations will be used in the construction of the landform, with the exception of the cable corridor which will be backfilled following installation. As such, the impact of waste generated from the scheme is considered to be **negligible**.

Increased risk of flooding

22.6.17 The proposed onshore development is not at risk from river or sea flooding according to the Environment Agency's Flood Zone map and is considered to have less than a 0.1% annual probability of river or sea flooding in any year. As such, the risk of flooding during construction is considered to be **negligible**. An FRA has been undertaken in accordance with PPS25 and is provided in full as **Appendix 22.D**.

Mitigation measures and residual impacts

22.6.18 In order to minimise potential impacts to geology, hydrology, hydrogeology and land quality associated with the construction phase (for example leaks or spills associated with construction works or disturbance of any existing areas of contamination), the project will develop a Construction Code of Practice (CCoP) that adheres to the EA Pollution Prevention Guidance (PPG) notes, as well as general good construction practice, including:

- PPG01 – General guide to the prevention of water pollution;
- PPG05 – Works near or liable to affect watercourses;
- PPG06 – Working at construction and demolition sites;
- PPG08 – Storage and disposal of used oils;
- PPG11 – Preventing pollution at industrial sites;
- PPG20 – Dewatering of underground ducts and chambers;
- PPG 21: Pollution incident response planning; and
    - To minimise the risk of accidental pollution incidents the CCoP will include a Pollution Incident Response Plan in line with PPG21. This will include mechanisms to control surface water run-off from the site and pollution prevention and response planning.
- Control of water pollution from construction sites – A guide to good practice, CIRIA (2001).

22.6.19 Other good construction practice measures to be incorporated into the CCoP include:

- Minimisation of length of time that excavations are kept open;

- Reinstatement of the excavated areas using suitable fill materials if required;
- Good site practice, hygiene and use of appropriate Personal Protective Equipment (PPE) and / or Respiratory Protective Equipment (RPE) to protect site workers if necessary;
- Construction excavation, earthmoving and soil storage areas to be located away from any surface water bodies, where practicable; and
- Consultation of suitably qualified environmental professionals if unexpected sources of pollution are encountered and undertaking of excavation work in accordance with a pre-agreed method statement.

22.6.20 Measures are required to minimise and deal with any excavated waste requiring offsite disposal in the appropriate manner and in line with relevant legislation. Mitigation measures to be adopted during the works are outlined below:

- Any material excavated and requiring disposal off site will be characterised and disposed of in accordance with the Landfill Regulations 2002 (as amended);
- Any imported filled material used for backfill would be tested to confirm that it is chemically and physically suitable for its proposed use;
- All potential waste activities will be undertaken in accordance with the Environmental Permitting Regulations 2010; and
- A Site Waste Management Plan (SWMP) will be prepared, which will ensure that any waste arising is closely monitored and that waste prevention, re-use or recycling opportunities are maximised.

Contamination of secondary aquifer (hydrogeology)

22.6.21 Given the lack or source hazards, and adherence to the good construction practices outlined above in paragraphs **22.6.18** and **22.6.19** this will ensure the likelihood of any spills are kept to a minimum by storing materials appropriately. If a spill does occur it would be managed appropriately and any clean up required will be undertaken accordingly. As such the likely significance of this impact will be reduced to **negligible**.

Soil erosion and runoff (hydrology)

22.6.22 Adherence to the good construction practices outlined above in paragraphs **22.6.18** and **22.6.19** will ensure that materials and operations are managed appropriately and the likely significance of this impact will be reduced to **negligible**.

Risk to site workers health (land quality)

22.6.23 Given the lack or source hazards, and adherence to good construction practices outlined in paragraphs **22.6.18** and **22.6.19** this will ensure that the likely significance of this impact is maintained as **negligible**.

Mobilisation of contaminants by rainfall (land quality / hydrogeology)

22.6.24 Given the lack or source hazards, and adherence to the good construction practices outlined in paragraphs **22.6.18** and **22.6.19** this will ensure that the likely significance of this impact is maintained as **negligible**.

Generation of waste materials

22.6.25 The likely significance of impact from the excavated materials associated with the substation footprint earthworks are considered to be **negligible** as the excavated materials are expected to be used within the landscape mitigation landform.

22.7 Assessment of Impacts during Operation

Geology and land quality

22.7.1 There are unlikely to be any operational impacts on the geology and land quality receptors as there will be no requirement for excavation or other ground disturbances.

22.7.2 Occasional maintenance works will be required during the operational phase; however, it is not anticipated that these will result in any ground disturbance. In the event of a cable failure, it may be necessary to re-excavate the cable trench and replace / repair the faulty cables along limited stretches. If repair works are required, the mitigation measures proposed previously for the construction activities will be adhered to, and possible impacts will be maintained as **negligible**.

Pollution of hydrological receptors

22.7.3 During operation the onshore development footprint will drain via infiltration – the drainage scheme is designed to accommodate rainfall associated with the 1 in 100 year event (plus climate change). In accordance with best practice all surface water runoff generated from hard standing areas within the main compounds, other than roofs, will pass through an oil separator before being discharged to ground to remove any hydrocarbon pollutants present in the runoff.

22.7.4 In the extremely unlikely event of a failure of all drainage systems (refer to the FRA for details) during an extreme rainfall event, surface water may result in some overland flood flows. These have the potential to move in the direction of Sizewell Marshes SSSI due to existing site topography. However, a band of woodland (approximately 40m wide) will be present between the substation and the SSSI. This will act as a natural buffer between the site and the SSSI.

22.7.5 Given the highly unlikely nature of such as event a **negligible impact** is predicted upon hydrological and hydrogeological receptors during the operation of GWF.

22.7.6 The oil filled transformers will be sited on bunded plinths, with underground oil containment, in case of leakage or full oil discharge in emergencies. This will ensure that oil leaks are fully contained and any oil can be taken offsite for appropriate disposal.

Flood risk and increased surface water runoff

22.7.7 The proposed substation site will not be at risk from river or sea flooding according to the Environment Agency's Flood Zone map and is considered to have less than a 0.1% annual probability of river or sea flooding in any year. As such, the risk of flooding during operation is considered to be **negligible**. A Flood Risk Assessment has been undertaken in accordance with PPS25 is provided as **Appendix 22.D**.

22.7.8 The proposed site is classified as 'greenfield'[5]. By replacing the existing grassland, arable and woodland with some impervious surfaces, there will be an increase in the surface water runoff associated with that area. However, newly created areas of hard standing (associated with the substation footprint and access road) are relatively small compared to the surrounding pervious surfaces throughout this coastal region.

22.7.9 The overall onshore substation footprint covers an area of 3.1ha. Of this approximately 1.4ha (45%) will comprise impermeable surfaces including the roofs of new buildings, all sealed roads and parking areas and the concrete plinths, which will be used to mount the electrical equipment. The remaining 1.7ha will comprise pervious surfaces (surfaced with chippings which will permit water infiltration). Surface water runoff has been calculated based on the 1 in 100yr (+ climate change) rainfall event and is reported in detail within **Appendix 22.D**.

22.7.10 A surface water drainage strategy has been developed to ensure that the surface water runoff rate remains as 'greenfield'. The drainage strategy incorporates Sustainable Drainage Systems (SUDS) to both reduce and attenuate surface water associated with the new development. Infiltration tests carried out for the neighbouring GGOWF substation site (in accordance with BRE Digest 365) have confirmed that ground conditions across the site are suitable for such techniques, with the poorest calculated infiltration rate ($1x10^{-5}$m/s) used within the design.

22.7.11 The drainage strategy includes the use of dry swales (shallow, typically grassed, drainage channels) along the access road, filter drains along of the inside toe of the landscape mitigation bund and soakaways within the substation compounds. The main compound areas will be drained via piped

[5] Previously undeveloped land

networks which collect the surface water runoff from other hard standing areas and will discharge it to ground via cellular soakaways.

22.7.12 There are limited downstream receptors and the potential for increased flood risk due to increased surface water runoff (based on the 1 in 100yr (+ climate change) rainfall event) is considered to be low. As such the risk of flood risk to downstream receptors in considered to be **negligible** in the absence of mitigation.

22.7.13 Discussions will be undertaken with SCDC and SCC regarding the long-term adoption and maintenance of the surface water features proposed in the drainage strategy.

22.8 Assessment of Impacts during Decommissioning

22.8.1 When GWF is decommissioned it will adhere to any future or modified legislation relevant at that time. The specific onshore decommissioning processes are expected to include:

- Export cables between the landfall and the substation site will be disconnected and left in situ;
- Any equipment installed within the onshore transition bays will remain in situ, unless otherwise agreed with the relevant planning authority;
- The above ground substation assets (comprising the GWF compound and the transmission compound) will be dismantled and removed from site;
- The substation foundations will be removed to 1m below ground level; and
- The landform will be retained.

22.8.2 The decommissioning phase of the substation is likely to be conducted in a similar manner to the construction phase, with similar mechanisms to mitigate the environmental impact. As such, the impacts from the decommissioning of GWF on geology, hydrogeology, hydrology, land quality and flood risk are considered to be equivalent to those assessed for the construction phase.

22.8.3 While it is not possible to identify future legislative requirements, using the current legislative framework as a model, it is anticipated that legislation equivalent to the current site waste management plan regulations is likely to provide a legal requirement and mechanism for appropriate waste management and materials recovery. However, some waste material will be generated through the decommissioning of the substation and as such this would be considered to be a **minor adverse impact**.

22.9 Inter-relationships

22.9.1 **Table 22.9** summarises the inter-relationships that are considered of relevance to geology, hydrogeology, land quality and flood risk and identifies where within the ES these relationships have been considered.

22.9.2 **Chapter 28 Assessment of Inter-relationships** provides a more detailed holistic overview of the potential impacts that may manifest on geology, hydrogeology, land quality and flood risk receptors.

Table 22.9 Geology, hydrology, hydrogeology, land quality and flood risk inter-relationships

Inter-relationship	Section where addressed	Linked Chapter
Contaminated surface water runoff and impacts on ecology / designated sites	Section 23.6	Chapter 23 Terrestrial Ecology

22.10 Cumulative Impacts

22.10.1 The unmitigated impacts identified during the construction (**Section 22.6**) and decommissioning phases (**Section 22.8**) of the GWF project that have the potential to result in cumulative effects comprise:

Construction

- The potential for contamination from leaks and spills from construction vehicles to affect the secondary aquifer (minor adverse);
- The potential for contaminated surface water runoff to affect nearby hydrological receptors (minor adverse); and
- Soil erosion and contaminated water runoff during construction to affect nearby hydrological receptors (minor adverse).

Operation

22.10.2 No impacts with effects above negligible are anticipated for the operational phases of the project as per **Sections 22.7** therefore no cumulative impacts are possible during the operation phase of GWF.

Decommissioning

- The potential for contamination from leaks and spills from construction vehicles to affect the secondary aquifer (minor adverse);
- The potential for contaminated surface water runoff to affect nearby hydrological receptors (minor adverse);
- Soil erosion and contaminated water runoff during construction to affect nearby hydrological receptors (minor adverse); and
- The creation of waste materials that cannot be re-used.

GWF construction and other onshore activities

22.10.3 Other onshore activities in the study area include the GGOWF onshore electrical connection, Sizewell B Dry Fuel Store, proposed new nuclear development (Sizewell C) and the decommissioning of Sizewell A.

GGOWF onshore electrical connection

22.10.4 GGOWF has a development footprint immediately adjacent to GWF and is expected to result in similar construction impacts. However, construction of GGOWF will be completed in 2011/2012 and as such there will be no overlap with the construction phase for GWF. Therefore there will be no cumulative impact associated with the construction of GWF and the construction of GGOWF.

Sizewell B Dry Fuel Store

22.10.5 The construction of the Sizewell B Dry Fuel Store has the potential for the following relevant impacts (British Energy, 2010):

- The potential for site workers to be in close or direct contact with contaminants, should any be present;
- The potential for spills and leaks from on-site activities and the storage of materials; and
- The generation of waste materials.

22.10.6 These impacts are considered to be localised to the footprint of the Sizewell B Dry Fuel Store and do not overlap with the GWF onshore development footprint. As such, **no cumulative impacts** are anticipated during the construction of GWF.

Sizewell C

22.10.7 This proposed development is expected to be located to the north of the existing Sizewell power station infrastructure. Construction is not expected to begin on Sizewell C until approximately 2017 at the earliest. Should the GWF onshore construction works extend beyond 2017 there is the potential for a cumulative impact upon terrestrial ecology receptors. Given the absence of any details of the Sizewell C proposals it is not possible to undertake a quantitative assessment of this potential cumulative impact at this stage.

Sizewell A decommissioning

22.10.8 The main decommissioning activity associated with this (the preparation for care and maintenance stage) is programmed to take place between 2009 and 2019 (British Nuclear Group, 2005). However, the associated ES did not report any significant impacts upon geology, hydrogeology, land quality or

flood risk receptors. Therefore there are not anticipated to be any cumulative impacts with the construction of GWF.

22.10.9 Overall there are considered to be **no significant cumulative impacts** between the construction of GWF and any other known or planned activities.

GWF decommissioning and other onshore activities

22.10.10 GWF will have an operational design life of 25 years and would be programmed for decommissioning in approximately 2045. At this stage the GGOWF onshore electrical connection will also be near the end of its operational design life, Sizewell B Dry Fuel Store and the proposed new nuclear development (Sizewell C) should both be operational and the decommissioning of Sizewell A will have entered its care and maintenance phase.

GGOWF onshore electrical connection

22.10.11 GGOWF also has an operational design life of 25 years and there is the potential that both GWF and GGOWF could be decommissioned at the same time. Given the proximity and similarity of these two onshore developments, decommissioning impacts are considered to be effectively the same should one or both developments be decommissioned. There is not expected to be an associated increase in magnitude for any of the reported impacts. Therefore there are not anticipated to be any cumulative impacts with the decommissioning of GWF.

Sizewell B Dry Fuel Store

22.10.12 Sizewell B Dry Fuel Store will still be operational at this time (expected to be operational until 2099).

22.10.13 The operation of the Sizewell B Dry Fuel Store has the potential for the following relevant impacts (British Energy, 2010):

- An increase in impermeable areas and road drains, resulting in a decrease in the level of infiltration during operation. This would have an associated increase in surface runoff volumes as less water is able to infiltrate the ground.

22.10.14 The decommissioning of GWF will not result in any increased impermeable surfaces or associated increased surface water runoff. As such, no cumulative impacts are predicted with the operation of Sizewell B Dry Fuel Store.

Sizewell C

22.10.15 It is assumed that Sizewell C will be operational in 2045. The expected operational lifetime of Sizewell C is in excess of 60 years (DECC, 2010) and the earliest that it would begin decommissioning would be approximately

2080. Given the absence of any details of the Sizewell C proposal it is not possible to undertake a quantitative assessment of the potential cumulative impact with the decommissioning of GWF at this stage.

Sizewell A decommissioning

22.10.16 Sizewell A will be in its 'care and maintenance' stage of decommissioning between 2019 and 2100. The associated ES did not report any significant impacts upon logy, hydrogeology, land quality or flood risk receptors during this stage (British Nuclear Group, 2005). Therefore there are not anticipated to be any cumulative impacts with the decommissioning of GWF.

22.10.17 Overall there are considered to be **no significant cumulative impacts** between the decommissioing of GWF and any other known or planned activities.

22.11 Monitoring

22.11.1 No monitoring is proposed for geology, hydrogeology, land quality or flood risk.

22.12 Summary

Table 22.10 Summary of the impact assessment for hydrology, hydrogeology and land quality

Description of Impact	Impact	Mitigation Measure	Residual impact
Construction Phase			
Impact to local geology	No impact	n/a	n/a
Contamination of secondary aquifer (hydrogeology)	Minor adverse	A CCoP will be developed that adheres to the EA Pollution Prevention Guidance (PPG) notes, as well as general good construction practice.	Negligible
Contamination of principal aquifer (hydrogeology)	No impact	n/a	n/a
Pollution of hydrological receptors (hydrology)	Minor adverse	A Construction Code of Practice will be developed that adheres to the EA Pollution Prevention Guidance (PPG) notes, as well as general good construction practice.	Negligible
Risk to site workers health (land quality)	Negligible		Negligible

Description of Impact	Impact	Mitigation Measure	Residual impact
Mobilisation of contaminants by rainfall (land quality)	Negligible		Negligible
Generation of waste materials	Negligible	n/a	n/a
Increased flood risk	Negligible	n/a	n/a
Operation Phase			
Geology, hydrology and land quality	Negligible	n/a	n/a
Pollution of hydrological receptors (hydrology)	Negligible	n/a	n/a
Flood risk and increased surface water runoff	Negligible	A drainage strategy will be implemented incorporating SUDS to ensure that a Greenfield runoff rate is maintained at the site.	Negligible
Decommissioning Phase			
As Construction Activities	As above	Impacts are considered to be similar to those of the construction phase	As above
Generation of waste	Minor adverse	Appropriate site waste management plan developed for decommissioning phase	Negligible

22.12.1 The unmitigated impacts identified during the construction, operation, and decommissioning phases of the proposed GWF project comprise minor adverse land quality impacts with respect to the secondary aquifer, contaminated surface water runoff and potential waste generation where materials excavated on site cannot be re-used. It has been identified that there will be no significant cumulative impacts arising from other activities in the area.

22.13 References

British Energy Generation Ltd (2010) Sizewell B Dry Fuel Store: Environmental Statement.

British Nuclear Group (2005) Sizewell A Environmental Statement

CIRIA (2001) Control of water pollution from construction sites – A guide to good practice

Department of Energy and Climate Change (2010) Planning For New Energy Infrastructure – Appraisal of Sustainability of the revised draft Nuclear National Policy Statement

Department of Energy and Climate Change (2011a) Overarching National Policy Statement for Energy (EN-1)

Department of Energy and Climate Change (2011b) National Policy Statement for Renewable Energy Infrastructure (EN-3)

Department of Energy and Climate Change (2011c) National Policy Statement for Electricity Network Infrastructure (EN-5)

Environment Agency (2006) CLEA UK Software V1.3

Galloper Wind Farm Ltd (2011) Galloper Wind Farm Preliminary Environmental Report

IPC (2010). Scoping opinion proposed Galloper Wind Farm Project, August 2010. Available at http://infrastructure.independent.gov.uk/wp-content/uploads/2010/09/Galloper-scoping-opinion_web.pdf

Royal Haskoning (2007). Contaminated Land Phase 1 Desk Based Assessment - Greater Gabbard Offshore Wind Farm Substation Site.

Royal Haskoning (2008). Phase II Environmental Baseline Survey - Greater Gabbard Offshore Wind Farm Substation Site).

Royal Haskoning (2011) Galloper Wind Farm Onshore Electrical Connection: Flood Risk Assessment.

Scottish and Southern Energy Renewables & RWE Npower Renewables (2010) Galloper Wind Farm Project Scoping Study